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Electrical Conductivity (EC) as an Effective Pedotransfer Function in the Prediction of Sodium Adsorption Ratio (SAR) in Soil System

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Abstract

Establishing relationships among indices of soil salinity has always been a challenging area offering new vistas in farming practices. Determination of soil sodium adsorption ratio (SAR) involves arduous and protracted laboratory investigations. Evolving methods to determine SAR based on simple soil salinity index will be more appropriate and economical. A linear regression model to predict soil SAR from soil electrical conductivity (EC) has been evolved; soil SAR could very well be worked out as a pedotransfer function of soil EC. The results of the study denote that the linear regression model SAR = SAR= 2.429672+0.422623EC with coefficient of determination, R^2 (0.797041) developed in the study can be a simple pedotransfer function in predicting soil SAR based on soil EC for the region and the correlation coefficient, r (0.838726) indicates a very strong positive correlation between EC and SAR.

Keywords: *Electrical Conductivity-Sodium Adsorption Ratio-pedotranfer function.*

1. INTRODUCTION

The soil Electrical Conductivity (EC) and the soil Sodium Adsorption Ratio (SAR) are presently accepted as indices of soil salinity though they are two different measures. Salinity is quantified in terms of the total concentration of such soluble salts, or more practically, in terms of the electrical conductivity of the solution, because the two are closely related (US Salinity Laboratory Staff, 1954).

Sodium adsorption ratio (SAR) specifies the effect of relative cation concentration on sodium accumulation in the soil and is, therefore, considered a more reliable process for determining this effect while EC is a measure of the total soluble salts concentration in a soil and reported as siemens per metre (S/m), or as decisiemens per metre (dS/m). (Siamak and Srikantaswamy, 2009); only soil EC has hitherto been part of routine agricultural soil analysis.

Soil EC and soil SAR are used to characterize soils as sodic or saline sodic. Sodium or alkali hazard is determined by the absolute and relative concentration of cations, *i.*e., the proportion of sodium (Na) to calcium (Ca) and magnesium (Mg) ions in a water sample and is expressed as SAR. Nata *et al.* (2008) reported that SAR and salinity combination could be effectively used to evaluate irrigation water quality in relation to infiltration or permeability problem in soil system.

Salt-affected soils occur in all continents and under almost all climatic conditions. The saline and sodic soils are estimated at 397 and 434 million hectares, respectively constituting about 15% of the global land area (FAO, 1997) based on the soil map of the world. In India, estimates ranging from 7.0 to 26.0 Mha were reported by various agencies that were inconclusive; Abrol and Bhumbla (1971) reported 7.0Mha, Massoud (1974) 23.2 Mha, NCA (1976) 7.16 Mha, SPWD (1993) 7.17 Mha, NRSA (1997) 3.90 Mha, NBSS and LUP (2002) 6.20 Mha. Extent and distribution of salt affected soils (368015 ha) in Tamilnadu State include 13231(ha) of Saline Soils and 354784(ha) of Sodic soils. The nature and properties of these soils are known to be varied necessitating specific approaches for their reclamation and management to sustain their long term productivity.

Screening of commercial crops for their tolerance towards sodicity is considered to provide better understanding and opportunities for farmers to grow them on such lands and to rehabilitate them.

For determining soil SAR, it is necessary to have exchangeable Na^+ , Ca^{2+} and Mg^{2+} and the soil Sodium Adsorption Ratio is given as : SAR = Na^+ / $[(Ca^{2+}+ Mg^{2+})/2]^{0.5}$ (Sumner 1993; Rengasamy and Churchman, 1999) where SAR is the Sodium adsorption ratio, (cmol kg-1)$^{0.5}$, and Na^+, Ca^{2+}, Mg^{2+} are Exchangeable Na^+ , Ca^{2+} and Mg^{2+} measured, respectively and expressed in cmol kg^{-1}.

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Determining exchangeable Na^+ , Ca^{2+} and Mg^{2+} always proved to be ordeal and prolonged one (Seilsepour and Rashidi 2008; Rashidi and Seilsepour 2008). It is often felt that determining soil SAR indirectly from comparatively a simpler soil salinity index like soil EC will be more apt and cost effective.

Substitutive approaches as pedotransfer functions are used for computing unmeasured variables based on statistical correlations of such variables with other soil properties; the cost and effort for determining such soil parameters are so high.

Empirical models have been attempted in the past five decades to predict certain difficult soil properties using simpler soil parameters/indices (USSL, 1954; MacDonald 1998; Krogh *et al*. 2000; Rashidi and Seilsepour, 2011).

Relationship between soil Sodium Adsorption Ratio (SAR) and soil Electrical Capacity (EC) have been documented; soil EC can be used to determine soil SAR (Richards, 1954; Emerson and Bakker, 1973; Rashidi and Seilsepour, 2011). Several attempts have since then been made to predict soil SAR from soil EC.

Such predictive models developed for different saline-zone soils are, however, not constant with the general models that could be extrapolated elsewhere. The relationships between soil properties as well are not constant, necessitating the estimations determined for the soil of interest and specified locations (Nadler and Magaritz, 1981; Marsi and Evangelou, 1991; Evangelou and Marsi, 2003; Rashidi and Seilsepour, 2011). Literature on soil SAR based on soil EC is, however, scant.

The Noyyal river basin has a total area of 3510 km3. (Location: between north latitude 10 56’ and 11 19’ and east longitude 76 41’ and 77 56’). Noyyal River flows to a distance of about 170 km. The basin has an average width of 25 km. The entire Noyyal basin is situated in the state of Tamilnadu, encompassing parts of Coimbatore, Erode (including recently formed Tirupur District as well) and Karur districts. The Noyyal confluences with the Cauvery River at Noyyal village.

Pollution, groundwater overdraft and increasing competition over scarce supplies make water a sensitive subject in the Noyyal basin of Tamilnadu. The basin was agricultural area earlier, irrigated through complex networks of diversion weirs, tanks and canals (Appasamy and Nelliyat, 2000).

Earlier studies of the authors (Usha and Haresh.M Pandya, 2015) and the pilot studies carried out for the present study have clearly established that there is pronounced location based and season bound variations in variables studied especially with reference to EC and SAR, and the relationship is crucial for determining the salinity conditions in the region.

The principal aim of this study therefore, was to evolve a soil SAR-EC model for Orathupalayam reservoir area of Noyyal River basin and to verify the efficiency of the developed model by comparing its results with those of the laboratory tests. The present study further focused on the general applicability of the model and to gain an insight on spatial temporal relations of the parameters EC and SAR, in view of the associations between the soil Electrical conductivity and different soil properties.

2. MATERIALS & METHODS

Sampling Locations

The locations were selected for soil sample collection based on pilot surveys in the vicinity of Orathupalayam reservoir, Noyyal River Basin, Tamilnadu, India

Analyzed according to the Köppen system, the area falls under the category **BShw (Semi-Arid Steppe Climate) (**Köppen, Wladimir , 1936). The coldest month is December. The months of March to May are hot and dry with mean monthly temperature around 32.5 °C and annual rain fall ranging between 100 and 150cm.

The study was confined to Orathupalayam in the vicinity of Orathupalayam Reservoir, spanning over a period of 3 consecutive years from September 2013 through February 2016 at different seasons. The area of study lies between 11.09-11.11 N latitude and 74.54-77.59 E longitude at an elevation of 245m above the Mean Sea Level (MSL).

In respective seasons, soil samples were collected at the same sites and horizons to register the evolution of the variables studied through seasons and consecutive years, with the locations initially chosen at random in respect of evolving model and its verification.

Timing

Soil samples were taken at regular intervals throughout the period of study and through seasons for analysis of various edaphic variables like silt, sand, clay, EC, pH, exchangeable Na^+, Ca^{2+} and Mg^{2+}. Care was taken to ensure that sampling occur at the same time of the day during different seasons in each area where samples were collected.

Representative sample

Each soil sample was ensured to be a composite consisting of the soil from core samples taken

randomly at several places in the immediate vicinity of the point of Sampling location. Samples were taken from surface (0-20 cm) and subsurface horizons (20-40 cm) and mixed thoroughly. The samples were carefully transported to the Laboratory and stored at 25 °C in a humidity chamber (RH ≈ 95%).

The methods of the Soil Survey Staff (1996) were adopted for analysis of soil physical and chemical properties *i.e.,* sand, silt and clay content , and pH, EC, Na^+, Ca^{2+} +Mg^{2+} of the soil samples Soil SAR-EC models were evolved based on EC measured and SAR computed from measured exchangeable Na^+, Ca^{2+} +Mg^{2+}. This information was used to produce predictions of SAR for the value of EC using the laboratory data set developed.

The results pertaining to the summer season of year 2013-2014 are given in the present paper based on 48 soil samples collected at random from different locations of experimental site of Orathupalayam.

A linear regression model was developed based on the EC and SAR of soil samples collected at random from 48 locations. The fitness of the model evolved for predicting SAR from EC is verified with EC and SAR data generated by laboratory test on soil samples collected from 18 different locations at random against the SAR values predicted from the soil SAR-EC model. For comparing the soil SAR values generated from laboratory tests on soil samples collected from 18 locations with the predicted SAR values from SAR-EC model, a paired sample t-test and the mean difference confidence interval approach was used. Microsoft Excel (version 2003-2007) was employed for statistical analyses. To find out the agreement between the soil SAR values measured by laboratory tests and the soil SAR values predicted using the soil SAR-EC model, Bland-Altman approach (1999) was used.

3. RESULTS & OBSERVATIONS

For all the physico-chemical properties of the soil samples collected at 48 locations the basic statistical parameters, and the values characterizing the distribution of the given features, *i.e.,* skewness and kurtosis were determined and are given in Table 1.

Among the physical and chemical features the lowest variability, as expressed by the coefficient of variation (CV) was recorded for the silt (1.28), and the highest CV was recorded for the EC at 16.65, respectively. In respect of Na and, Ca^++Mg^+, CV was found to be of the order 4.95 and 4.96.

Of these parameters EC and SAR of soil samples collected at random from 48 different locations were used in the determination of the soil SAR-EC model based on the outcome of modified t-test for correlation (Tables 2 and 3). The correlation coefficient between EC and Na+ (r = 0.91), between EC and SAR (r = 0.84) and between Na and SAR (r=0.98) all indicate suitability for developing pedotransfer function for SAR prediction in soils of Orathupalayam region of Noyyal River Basin.

The regression model for relationship between EC and SAR is given as SAR= 2.429672+0.422623X (Table -3). The p value of the independent variable is 9.97E-14. The coefficient of determination (R^2) and coefficient of variation (CV) are 0.703462 and 3.8%, respectively. The R^2 (0.703462) and the adjusted R square (0.697015) are two statistics used in assessing the fit of the model; the values are close to 1 suggesting better fit. The correlation coefficient r is 0.838726 indicating a very strong positive correlation between EC and SAR. The coefficient of determination R^2 implies that about 70% of the relationship is the result of EC, the factor being considered.

Table 1. Physico-chemical characteristics of soil samples used in evolving Soil SAR-EC model

	N	Mean	Median	Std Dev	SE Mean	Min	Max	g1	g2	C.V.
Sand	48	17.965	18.160	0.836	0.121	16.24	19.76	-0.05613	5.89437	4.65
Silt	48	47.882	48.035	0.614	0.089	46.16	49.12	-0.71937	7.56530	1.28
Clay	48	34.153	34.050	0.926	0.134	32.55	36.38	0.31784	6.03092	2.71
pH	48	8.415	8.405	0.144	0.021	8.16	8.68	0.09313	5.35889	1.71
EC	48	3.070	3.165	0.511	0.074	2.21	3.83	- 0.12294	4.96150	16.65
Na	48	9.026	8.12	9.280	0.447	0.064	9.51	-0.67586	5.27474	4.95
Ca+Mg	48	11.773	11.555	0.584	0.084	11.16	13.25	1.15315	6.58077	4.96
SAR	48	3.727	3.840	0.257	0.037	3.16	3.99	-0.85178	5.69401	6.90

Table 2. Modified t-test for Correlation among the variables of the soil samples collected at random from 48 locations

Number of Variables: 8 Number of Localities: 48

Variable 1	Variable 2	Covariance	P(Cov)	Correlation	Conventional P(Cor)	CRH		
						Corrected P(Cor)	Effective Sample Size	+/-
Sand	Slit	-0.55875	0.57633	-0.21327	0.14556	0.61648	7.86422	
Sand	Clay	-1.37507	0.16911	-0.76147	0.00000	0.20464	4.26098	-
Sand	pH	-0.10360	0.91749	-0.01718	0.90771	0.91919	37.34342	
Sand	EC	0.22914	0.81876	0.08533	0.56418	0.83782	8.21139	
Sand	Na	0.18415	0.85390	0.07379	0.61819	0.87201	7.22820	
Sand	Ca+Mg	-0.30958	0.75688	-0.12026	0.41553	0.78413	7.62636	
Sand	SAR	0.22592	0.82127	0.09254	0.53161	0.84425	6.96033	
Silt	Clay	-1.15786	0.24692	-0.47090	0.00073	0.28377	7.04587	-
Silt	pH	-0.05553	0.95571	-0.00988	0.94687	0.95677	32.59835	
Silt	EC	0.48531	0.62745	0.14433	0.32771	0.64935	12.30619	
Silt	Na	0.22209	0.82425	0.07029	0.63499	0.83745	10.98397	
Silt	Ca+Mg	-0.35766	0.72060	-0.11053	0.45452	0.73964	11.47037	
Silt	SAR	0.24723	0.80473	0.07991	0.58924	0.81995	10.57094	
Clay	pH	0.13235	0.89470	0.02207	0.88163	0.89689	36.95977	
Clay	EC	-0.45772	0.64715	-0.17281	0.24017	0.68195	8.01577	
Clay	Na	-0.27939	0.77995	-0.11326	0.44339	0.80722	7.08489	
Clay	Ca+Mg	0.46432	0.64242	0.18193	0.21588	0.68044	7.51397	
Clay	SAR	-0.32967	0.74165	-0.13658	0.35464	0.77460	6.82635	
pH	EC	1.29427	0.19557	0.24282	0.09632	0.20090	29.41070	
pH	Na	2.04537	0.04082	0.39320	0.00570	0.03823	28.05968	
pH	Ca+Mg	-2.13816	0.03250	-0.42283	0.00275	0.02940	26.57143	
pH	SAR	2.17212	0.02985	0.42686	0.00248	0.02671	26.89352	
EC	Na	2.44881	0.01433	0.91033	0.00000	0.00134	8.23624	
EC	Ca+Mg	-1.66129	0.09666	-0.58756	0.00001	0.09631	8.99431	-
EC	SAR	2.23324	0.02553	0.83873	0.00000	0.00871	8.08976	
Na	Ca+Mg	-2.10110	0.03563	-0.80550	0.00000	0.01777	7.80389	
Na	SAR	2.40978	0.01596	0.98031	0.00000	0.00010	7.04263	
Ca+Mg	SAR	-2.30845	0.02097	-0.90583	0.00000	0.00312	7.49453	

+ = Gain of Significance - = Loss of Significance

Table 3. Linear regression model evolved (The p-value of independent variable, coefficient of determination (R^2) and coefficient of variation (CV) of the Soil SAR-EC model)

Model	Independent variable	p-value	R^2	CV
SAR= a+bX	EC	9.97E-14	0.703462	3.8

SAR= 2.429672+0.422623X, where 'a' and 'b' are regression coefficients; X independent variable, EC

To verify the soil SAR-EC model evolved, the SAR predicted for the corresponding EC values were compared to SAR of the laboratory tests. 18 soil samples were taken at random in the experimental area. The various parameters of the soil samples collected from 18 locations and employed to validate the soil SAR-EC model are given in Table 4. Modified t test for the correlation among the variables studied are given in Table 5.

SAR data generated from Laboratory Test on soil samples collected at random from 18 different locations and SAR computed using SAR-EC model for the corresponding EC values for the evaluation of SAR – EC model are given in Table 6.

The soil SAR values measured by laboratory tests were compared with SAR values predicted using the soil SAR-EC model for the corresponding EC values employing, a paired samples t-test and the mean difference confidence interval approach and the findings are presented in Table 7.The mean difference between the SAR from laboratory test and SAR computed from SAR-EC model was found to be 0.023111 with 95% confidence intervals for the difference in means ranging from -0.027743 to 0.073965 (cmol kg-1) with a p-value of 0.351082.

The results indicated that the difference between the SAR values predicted with the SAR-EC model and the laboratory generated SAR values were not statistically significant implying that the model evolved is good and fit.

The agreement between the soil SAR values measured by laboratory tests and the soil SAR values predicted using the soil SAR-EC model was worked out adopting Bland-Altman approach (1999) and given in Fig.1.

Table 4. Physico-chemical characteristics of soil samples used in validating soil SAR-EC model

	N	Mean	Median	Std Dev	SE Mean	Min	Max	g1	g2	C.V.
Sand	18	18.275	18.285	0.866	0.204	16.45	19.62	-0.12224	7.09825	4.74
Silt	18	46.332	46.200	1.467	0.346	43.16	49.37	-0.08085	7.75120	3.17
Clay	18	35.504	35.295	1.708	0.403	31.32	38.43	-0.52586	8.31434	4.81
pH	18	8.528	8.560	0.140	0.033	8.27	8.73	-0.27730	6.07771	1.64
EC	18	3.014	3.180	0.471	0.111	2.18	3.64	-0.50405	6.09642	15.63
Na	18	9.051	9.285	0.464	0.109	8.19	9.51	-0.67154	6.01645	5.13
Ca+Mg	18	11.809	11.710	0.437	0.103	11.28	12.67	0.88441	6.67792	3.70
SAR	18	3.728	3.814	0.240	0.057	3.27	3.96	-0.82950	6.41541	6.44

Table 5. Modified t-test for Correlation among the variables of the soil samples collected at random from 18 locations

Number of Variables: 8 Number of Localities: 18

Variable 1	Variable 2	Covariance	P(Cov)	Correlation	Conventional P(Cor)	CRH		
						Corrected P(Cor)	Effective Sample Size	+/-
Sand	Slit	-0.33787	0.73546	-0.12673	0.61630	0.76270	8.10788	
Sand	Clay	-1.06988	0.28467	-0.39719	0.10265	0.31900	8.25541	
Sand	pH	0.46500	0.64193	0.12283	0.62727	0.65860	15.33045	
Sand	EC	0.61400	0.53921	0.15070	0.55057	0.55576	17.59956	
Sand	Na	0.43585	0.66295	0.10944	0.66554	0.67733	16.86067	
Sand	Ca+Mg	-0.97587	0.32913	-0.22174	0.37654	0.34242	20.36907	
Sand	SAR	0.57663	0.56419	0.13986	0.57991	0.57993	17.99787	
Silt	Clay	-1.44186	0.14934	-0.81815	0.00003	0.16852	4.10584	-
Silt	pH	-1.67190	0.09454	-0.54406	0.01959	0.09435	10.44343	-
Silt	EC	-0.46866	0.63931	-0.12898	0.61000	0.65755	14.20253	
Silt	Na	-0.68686	0.49217	-0.18268	0.46812	0.51233	15.13693	
Silt	Ca+Mg	0.50243	0.61536	0.13235	0.60063	0.63275	15.41243	
Silt	SAR	-0.67706	0.49837	-0.17856	0.47838	0.51812	15.37731	
Clay	pH	1.51237	0.13044	0.50447	0.03276	0.13735	9.98756	-
Clay	EC	0.35665	0.72136	0.09369	0.71155	0.73494	15.48997	
Clay	Na	0.61185	0.54063	0.15626	0.53579	0.55857	16.33153	
Clay	Ca+Mg	-0.20159	0.84024	-0.05314	0.83414	0.84853	15.39256	
Clay	SAR	0.56112	0.57471	0.14084	0.57724	0.59140	16.87395	
pH	EC	1.90457	0.05684	0.59219	0.00962	0.05026	11.34357	-
pH	Na	2.02688	0.04267	0.55059	0.01789	0.03675	14.55201	
pH	Ca+Mg	-2.31846	0.02042	-0.71032	0.00096	0.01104	11.65332	
pH	SAR	2.21338	0.02687	0.63287	0.00482	0.01893	13.23147	
EC	Na	2.85466	0.00431	0.89795	0.00000	0.00016	11.10657	
EC	Ca+Mg	2.27595	0.02285	-0.73386	0.00053	0.01197	10.61838	
EC	SAR	2.78905	0.00529	0.91016	0.00000	0.00018	10.39024	
Na	Ca+Mg	-2.35237	0.01865	-0.69558	0.00135	0.01021	12.43727	
Na	SAR	3.07666	0.00209	0.98036	0.00000	0.00000	10.84885	
Ca+Mg	SAR	-2.56897	0.01020	-0.82319	0.00003	0.00217	10.73896	

+ = Gain of Significance - = Loss of Significance

Table 6. Evaluation of SAR –EC model based on the SAR of Laboratory Test and SAR computed using SAR-EC model for the corresponding EC values

Sample	EC(dS m^{-1})	SAR (cmol kg^{-1})	
		Laboratory test	SAR computed based on SAR-EC Model
1	2.28	3.352	3.394
2	2.18	3.266	3.351
3	2.34	3.329	3.418
4	2.49	3.514	3.482
5	2.71	3.481	3.575
6	2.74	3.792	3.588
7	3.12	3.931	3.748
8	3.28	3.655	3.816
9	3.17	3.814	3.769
10	3.37	3.927	3.854
11	2.68	3.653	3.562
12	3.19	3.916	3.778
13	3.24	3.815	3.799
14	3.34	3.956	3.841
15	3.42	3.932	3.875
16	3.49	3.948	3.905
17	3.58	3.93	3.943
18	3.64	3.901	3.968

Table 7. Paired sample t- test analysis comparing soil SAR of Laboratory test and SAR predicted from SAR-EC model

Mode of SAR determination	Mean of differences (cmol kg-^{1})	Standard deviation of differences (cmol kg-^{1})	p-value	95% Confidence intervals for the difference in means (cmol kg-1)
Laboratory test vs. SAR- EC Model	0.023111	0.102262	0.351082 *	-0.027743 to 0.073965

*By conventional criteria, this difference is considered to be not statistically significant.

The agreement between the soil SAR values measured by laboratory tests and the soil SAR values predicted using the soil SAR-EC model was worked out adopting Bland-Altman approach (1999) and given in Fig.1.

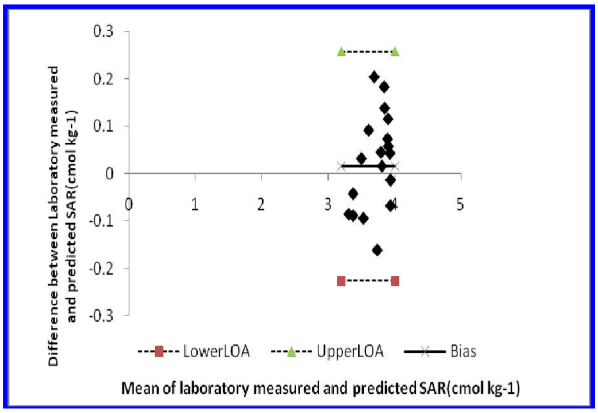

Fig.1: Bland Altman Plot of the data obtained from Laboratory Test and the computed SAR from SAR-EC Model for comparison Bias (0.024778); the lower and upper LOA being -0.17389 and 0.223447, respectively. Correlation R= 0.838726 (p<0.01); Slope = 0.422623 (p<0.01); Intercept = 2.429672(p=1.08E-23)

The 95% lower limit of agreement and the upper limit of agreement were found to be -0.17389 and 0.223447, respectively with a bias or mean of differences of 0.024778 between the laboratory generated SAR data and the SAR computed from SAR-EC model denoting that the SAR values predicted by SAR-EC model can be -0.17371 lower or 0.223373 higher than the SAR values generated from laboratory tests, and the SAR differences between the two modes of SAR determination were normally distributed.

4. DISCUSSION

A soil system is considered as a network of soil properties and any soil characteristic cannot be absolutely independent, standing by itself. There exist many intricate interrelations between soil and other properties that can be described statistically (Bouma and Droogers, 1998; Bouma, 2002). Further, soil traits are known to vary significantly even within one soil type which need necessarily be given due consideration (Stafford *et al.* 1996).

Analysis of spatial distribution and correlation of soil properties represents an important outset for

precision agriculture (Bruvka *et al.* 2002) which is currently promoted and implemented in the most economically developed countries.

A meticulous analysis of distribution of soil properties, therefore, will offer a basis for defining different management zones on a field. Saline and sodic soils have received much attention in recent times as they pose a challenge to agriculture and its management in view of their extent of distribution alarmingly expanding over the continents.

Continued applying of irrigation water with a high SAR to a soil for years has been reported to displace the calcium and magnesium in the soil by sodium in the water. Consequently this causes a decrease in the capacity of the soil to form stable aggregates and ultimately a loss of soil structure. Further, such condition leads to a decline in infiltration and permeability of the soil to water resulting in problems with crop production (Sumner 1993; Rengasamy and Churchman, 1999)

A practical methodology is required for the timely assessment of soil salinity in irrigated fields, for determining its causes and for evaluating the aptness of related management practices.

Salinity is quantified in terms of the total concentration of such soluble salts, or more practically, in terms of the electrical conductivity of the solution, as the two are closely related (US Salinity Laboratory Staff, 1954). These two soil parameters, as a general practice, are used to characterize soils as sodic or saline sodic. Only EC has been a part of routine agricultural soil analysis as Soil electrical conductivity relates directly to salinity (USDA, 2011).

Only relatively recently that SAR has started gaining increased attention as it is responsible for the sodium or alkali hazard in irrigation water (Tiwari and Manzoor, 1988; Siamak and Srikantaswamy, 2009). Sodium or alkali hazard is determined by the absolute and relative concentration of cations, *i.*e., the proportion of sodium (Na) to calcium (Ca) and magnesium (Mg) ions in a soil water sample.

The degree to which irrigation water tends to enter into cation-exchange reactions in soil is well indicated by the SAR and the excess sodium in waters bring in undesirable effects of changing soil properties and reducing soil permeability. Sodium, when replacing adsorbed calcium and magnesium becomes hazardous as it causes damage to the soil structure.

Relationship between soil Sodium Adsorption Ratio (SAR) and soil Electrical Conductivity (EC) have been documented and soil EC can be used to determine soil SAR (Richards, 1954; Levy and Hillel, 1968; Emerson and Bakker, 1973; Rashidi and Seilsepour, 2011). Several attempts have since then been made to predict soil SAR from soil EC. The soil Electrical Conductivity (EC) and the soil Sodium Adsorption Ratio (SAR) are currently accepted as indices of soil salinity though they are two different measures.

Determining exchangeable Na^+ , Ca^{2+} and Mg^{2+} always proved to be ordeal and prolonged one (Seilsepour and Rashidi, 2008; Rashidi and Seilsepour, 2008) to arrive SAR. It is often felt that determining soil SAR indirectly from comparatively a simpler soil salinity index like soil EC will be more apt and cost effective in view of the difficulties , enormous time and exorbitant cost involved in the estimation of SAR from exchangeable Na^+,Ca^{2+} and Mg^{2+}

Pedotransfer functions were used for developing empirical predictive models to estimate the needed properties, and prediction performances were then analyzed. Such models offer the most scientific way of conceptualization of the processes and soil dynamics.

As early in 1954, the United States Salinity Laboratory (USSL) evolved a model to predict soil Exchangeable Sodium Percentage (ESP) using soil Sodium Adsorption Ratio (SAR) as ESP = – 0.0126 + 0.01475 SAR for United States soils (Richards, 1954). Rashidi and Seilsepour (2011) developed a model for SAR based on soil EC as SAR=1.91+0.68EC.

On the same line an SAR-EC model (SAR= 2.429672+0.422623X) was evolved with EC as the pedotransfer function, for predicting SAR for the given EC values for the soil in the Orathupalayam region in the Noyyal River Basin. The predicted SAR values, based on SAR-EC model evolved was found to be effective.

The SAR values predicted by SAR-EC model can be -0.17389 lower or 0.223447 higher than the SAR values generated from laboratory tests and the SAR differences between the two modes of SAR determination were normally distributed.

Soil EC measurement seems to be an excellent cost effective management decision which consequently could well be used as part of the strategic planning for irrigation schedule, farming practices, predicting SAR values and sodium hazard.

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